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ENHANCING RURAL LIVELIHOODS IN ASALS THROUGH FEEDLOT FINISHER RATION VALIDATION FOR SMALL RUMINANTS' EARLY MARKETS

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Abstract

This study aimed to identify intensive small ruminant rearing and feedlot finishing rations based on evaluated small ruminant grass-legume finisher rations among Dorper sheep farmers in Narok County. Feedlot finishing rations are limited in Kenya, perhaps due to a paucity of sheep and goat finishing formulae on the market, coupled with a lack of expertise in formulation. The experiment used a Completely Randomised Design (CRD) with three groups: TR0 (control, traditional grass grazing), TR6 (Ration 6), and TR8 (Ration 8). Each treatment involved 10 sheep, with the control replicating farmers' current practices. The trial assessed growth performance metrics, including average daily weight gain (ADG) and final market weights, along with meat quality evaluations using a Linkert scale and semi-structured questionnaires. After 12 weeks, significant differences ($p<0.044$) in market weight were observed. Sheep on Ration 8 achieved the highest mean weight (45.8 kg), followed by Ration 6 (40.8 kg), while control group had the lowest (38.1 kg). The organoleptic evaluation revealed that ration 8 produced well-marbled, tasty, and juicy meat, ideal for barbecue preparation. Ration 6 yielded tender, soft meat with less fat cover suited for marination and stew. The control group produced tougher, less fatty meat that tended to burn during roasting. Meat quality ratings showed a preference for feed trial carcasses over the control, although the assessment was limited to roasted meat, excluding fried or boiled samples. The findings underscore the potential of formulated finisher rations, particularly Rations 8 and 6, to improve growth performance and meat quality, addressing market demands for premium sheep products.

Key terms: ASAL, Dorper sheep, feedlot, finisher rations.

1.0 INTRODUCTION

Kenya is facing a pressing challenge of youth unemployment, with individuals aged 15-34 years comprising 35 per cent of the population and experiencing an unemployment rate of 67 per cent (Gachanja et al., 2023; KNBS, 2019). This issue is compounded by high poverty levels, with 33.4 per cent of Kenyans living below the poverty line and frequent droughts exacerbating food insecurity(KNBS, 2019). Addressing youth unemployment is critical to curbing the associated rise in criminal activities, including drug abuse, violence, and burglary, which often emerge from economic despair (Greschner, 2023). One promising strategy to empower the youth is the adoption of feedlot finishing systems, which can create market-oriented livestock enterprises, reduce rearing periods, and increase economic returns (Hanel, 2022; Malabo Panel, 2020; Wambuka, 2017).

Feedlot finishing, a system that involves fattening small ruminants like sheep under controlled feeding conditions, is a potentially transformative approach for Kenya. It allows farmers to achieve higher market weights in shorter periods—reducing rearing durations from 2-3 years under extensive grazing to approximately seven months for breeds like Dorper sheep (Assefa, 2020; Tegegne & Feye, 2020). This system not only reduces risks associated with long-term rearings, such as mortality, theft, and drought losses but also provides a sustainable model for increasing meat production (Mosalagae & Mogotsi, 2013; Steyn De Wet, 2018). Sheep play a vital role in food production, rural employment, and Kenya's gross national product by converting roughages into valuable products such as meat, wool, and skins (Geoff & Wilson, 2009).

Despite Kenya being a net importer of meat and meat products, the growing urbanisation and income levels are driving an increased demand for high-quality mutton, both for domestic consumption and export. However, the current production systems result in low slaughter weights and extended rearing periods, limiting the sector's potential. Youth-led feedlot systems offer a pathway to improve meat quality and supply while addressing unemployment through agribusiness opportunities.

This introduction provides an overview of the challenges and opportunities presented by feedlot finishing systems in Kenya, emphasising their relevance to addressing youth unemployment, food security, and sustainable livestock production. The subsequent discussion will elaborate on the economic, social, and environmental benefits of this system and its potential to transform small ruminant production in Kenya.

3.0 METHODOLOGY

The study employed an on-farm validation approach to evaluate two best-bet Dorper sheep finisher rations (TR6 and TR8) against a control group under farmer-managed conditions in Narok County. The study site was selected due to its agro-pastoral significance, and participant recruitment was conducted through the AFAPO CBO. Farmers were purposively selected based on criteria such as owning at least 30 entire male Dorper sheep and meeting infrastructural requirements (e.g., land ownership and water availability).

A completely randomised design (CRD) was adopted with three treatments: the control (farmers' practice without supplementation), TR6 (10 MJ/kg DM; 16% CP), and TR8 (11 MJ/kg DM; 14% CP),

each replicated 10 times. Thirty male Dorper weaner sheep (3-4 months old) were randomly assigned to three groups of 10 animals per treatment. An initial adaptation period of 10 days was allowed, during which the animals acclimatised to the feed and environment.

The rations were formulated using Feedsoft® Professional software and included locally sourced ingredients such as Rhodes grass, Lucerne hay, sunflower cake, and wheat bran. Animals were fed at 3 per cent of live body weight daily, with water and mineral salts provided ad libitum. On-farm data collection focused on two key aspects: growth performance and meat quality evaluation (Joshi et al., 2015).

The study collected data on existing Dorper sheep management practices to evaluate routine farm operations before implementing the research on finishing rations. Using a checklist, information on weaning, disbudding, ear tagging, castration, vaccination schedules, disinfection, and quarantine was gathered, alongside data on animal health, nutrition, reproduction, grazing management, and marketing. Table 4.1 revealed gaps in recommended practices, such as lack of disbudding, ear tagging, and comprehensive vaccination schedules (e.g., PPR and Foot-and-Mouth Disease). Reproduction practices were largely uncontrolled, and nutrition and marketing linkages were inadequate. The findings highlight significant omissions in routine management, necessitating the adoption of best practices to enhance productivity and profitability.

Table 4.1 Existing Description of Farmer management practices of Dorper sheep among Agro-pastoral communities in Narok County
CHECKLIST

	Management practices	**Farmers' practice**	**Recommended practice**
1	**Weaning practices**		
a.	Docking	√	√
b.	Disbudding	0	√
c.	Ear tagging	0	√
d.	Castration	0	√/0 (control inbreeding)
6.	**Vaccination schedules**		
a.	PPR	0	√
b.	Blue tongue	√	√
c.	Foot and Mouth Dse	0	√
7.	Deworming	√	√
8.	Reproduction (Mating age, source of breeding ram)	Uncontrolled	controlled
9.	Disinfection & quarantine	0	√
10.	Nutrition (supplementation: minerals, concentrates, sources	0	√
11.	Production system (Intensive, semi-intensive, extensive)	Extensive	Intensive/semi
12.	Dorper sheep marketing and marketing linkages	0	√

Weekly weight gains and final market weights of the experimental Dorper sheep were recorded, with means calculated for initial, weekly, and final weights. Meat quality assessment involved organoleptic evaluation and farmers' perceptions of the mutton produced from the tested rations (TR6, TR8, and control). Using a Likert scale (1-5), stakeholders ranked the rations based on growth performance, outward appearance, and meat quality traits like tenderness, juiciness, flavour, fatness, and leanness. Three sheep per treatment were slaughtered, and meat samples were prepared for sensory evaluation by five panellists, following standardised procedures.

The collected data were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS, 2003). The model included the test rations as the main effect, with animal performance (weekly weight gain and final slaughter/market weight) as the dependent variables. To control for potential confounding factors, variables such as animal age, sex, and baseline weight were included as covariates in the model. Additionally, variations in farm management practices, such as feeding and health protocols, were accounted for through random effects or stratification where applicable. Assumptions underlying the ANOVA, including normality, homogeneity of variance, and independence of residuals, were tested using diagnostic plots and statistical tests (e.g., Shapiro-Wilk for normality, Levene's test for homogeneity). Where assumptions were violated, data transformations or non-parametric alternatives were considered. Least Significant Difference (LSD) was employed for mean separation, with adjustments for multiple comparisons to minimise Type I error rates. These steps ensure the reliability and robustness of the statistical analysis.

4.0 RESULTS AND FINDINGS

Species Composition for Control Sheep

The key species identified in the plot was Boma Rhodes (*Chloris gayana*). This is a perennial palatable species commonly found in woodlands and open grasslands. It is a good species for grazing and cut-carry for haymaking. It is known for its drought tolerance and high salt tolerance and is sometimes tolerant to heavy grazing. It develops good ground cover wherever it is found and is, hence, very suitable for soil erosion control and conservation of soil moisture. However, it is known to have a short season of nutritive peak; hence, it is likely to deteriorate when left ungrazed or uncut. Currently, many farmers in Kenya cultivate the grass, and it is widely grown in Narok County for hay and seed production. Reported yields of up to 25 tons DM per hectare have been recorded under cut-carry systems.

On the farmer field, the species was established around 5 years ago to improve pastures on the farm; hence, the site where the animals were grazing was one of the areas where the grass was sown for livestock. The farmer had been using the site previously for continuous grazing of his dairy animals, and it is likely that productivity deteriorated over time due to the failure of rains in the last few seasons.

Other species identified, though very minimal, included some sedges, annual grasses (unknown) *Digitaria macroblephara*, *Penisetum spp*, *Digitaria scalarum* and Naivasha star grass. Some unpalatable legume species were also identified, though they were not very common. However, one particular legume species was also identified in the field and has been known to be commonly overgrazed in the fields.

Over the three months, species composition remained largely unchanged, with no significant shifts observed in the field. However, a notable decline in annual palatable legumes was recorded as the season progressed. This decline could be attributed to several factors, including natural life cycle completion of annual species, grazing pressure that preferentially targets palatable legumes, and changes in environmental conditions such as reduced soil moisture or increased competition for resources. Additionally, the decline may be influenced by inadequate seed bank replenishment or the limited regeneration capacity of these legumes under prevailing grazing and climatic conditions.

Cover and Height

The cover in percentage and height (cm) over the experimental period was as in Table 1, where there was an increase from the month of April followed by an increase and a reduction.

Table 1: cover percentage over the experimental period.

Month	**April**	**May**	**June**	**Mean**	***p*-value**
Cover (%)	24.3 a	77.7 c	44.7 b	46.9	< 0.001
Height (cm)	7.05 a	18.48 b	7.28 a	10.9	< 0.001

In March, at the beginning of the experiment, the sampling could not be done as hardly any vegetative material was on the ground. However, after the onset of the rains, a rapid regrowth of vegetation was observed and the cover at the time of sampling was found to be 24.3 per cent. On the other hand, the height of the grasses was at 7.05 in April and grew to 18.48 during the peak of the season and declined to 10.9 in June. An increase was observed in the subsequent month due to more rainfall being received at the site, but a further decline in the third month was witnessed as a result of declining rainfall and the effects of grazing. Reported values are only at the point of sampling and do not necessarily indicate the values over the whole month.

It is worth noting that when *Chloris gayana* grasses are grazed, they tend to develop and grow differently as a response to defoliation. Naturally, the grasses usually grow taller, but continuous grazing tends to restrict their upward growth. They are likely to spread on the ground or remain shorter, depending on the intensity and frequency of grazing.

Biomass Production for Control Sheep

The fresh weight biomass obtained from the field was as indicated in Table 2.

Table 2: Fresh weight biomass obtained over the 3-month period.

Month	**April**	**May**	**June**	**Mean**	***p*-value**
Biomass (kg/ha)	4,975 a	8,217 b	4,017 a	5,736	<0.001

Just as was observed in parameters of cover and plant height, a yield increase was observed from the plots in the month of May compared to April, and the decline was observed in June. The same explanation of rainfall and grazing effects explain the trends.

The lower biomass yields observed in this study, compared to the benchmark value of 11,000 kg/ha, can be attributed to frequent grazing in the field, including grazing by sheep during the experimental period. This overgrasing likely depleted plant resources, reducing regrowth capacity and overall pasture productivity. Such grasing pressure can negatively impact biomass availability, leading to reduced animal productivity.

Nutritive Value of the Control Group Pasture Forages

The nutritive value of the grass samples varied, as shown in Table 3.

Table 3: Nutritive value of grasses from the control field

Element	April	May	June	Mean	P Value
Crude protein %	17.33 b	13.57 a	12.66 a	14.52	0.004
Ash %	16.36 a	18.72 a	16.03 a	17.04	0.04
Crude fibre %	23.48 a	26.62 ab	27.42 b	25.84	0.036
Dry matter %	90.87 a	92.43 b	92.13 b	91.81	<0.001
Ether extract %	5.59 a	5.84 a	4.58 a	5.34	0.217

The nutritive values obtained from the field and laboratory indicate that these were high-quality pastures. High crude protein, low ash as well as crude fibre indicate that there is likely to be better animal productivity for sheep grazing in these pastures as they lie within the acceptable limits for livestock nutrient requirements. Ether extract is an approximate of total fat in a constituent feed and hence, animals grazed on these pastures are likely to have less fat in the carcass.

On-Farm Growth Performance Trials

The performance of weaner Dorper sheep as influenced by finisher rations is presented in Table 1. A covariate is a variable, such as entry live weight, that is measured alongside the main treatment factor. It is a potential source of variation that is taken into account to assess its influence on the response variable viz live weight (kg) for wk1-wk12). The *p*-value associated with a covariate was 0.052, which suggests that there was no significant effect between the covariate (Entry weight) and the live weights over the 12-week study period.

A significant ($p<0.044$) difference was observed among the treatments in week 12. Treatment Ration 8 (TR8) had the highest mean weight (45.8 kg), followed by Treatment 6 (40.8 kg), while the Control group had the lowest mean weight (38.1 kg). The final mean market live weights of treatments TR8 (45.8 kg) and TR6 (40.8 kg) were statistically similar (Table 1), while the mean live weight of the control group (38.1 kg) was different from these treatments in week 12.

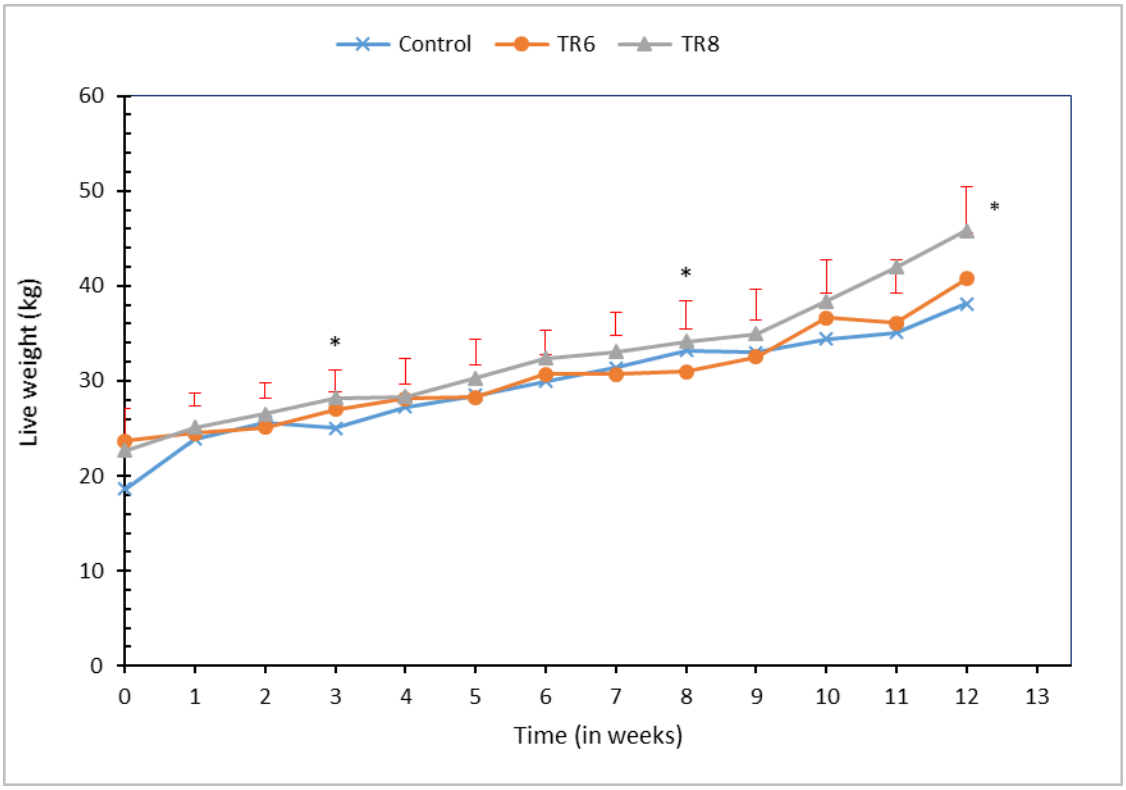
Dorper sheep breed adapts well to harsh climatic conditions and matures faster than other ordinary sheep, such as blackhead Persian and/or merino sheep. These traits can be tapped in an

agribusiness model and science to contribute to better production, better nutrition, better environment and better life and *livelihoods* in Kenya's drylands.

Table 1: The Influence of Finishing Rations on Weekly Live Weight gain (kg) of Dorper Sheep

Time	Control R0	Treatment R6	Treatment R8	p-value	LSD $_{(0.05)}$	CV (%)
Entry weight	18.6 a	23.7 a	22.7 a	0.052	4.1	19.7
Wk1	23.9 a	24.5 a	25.1 a	0.159	1.4	5.0
Wk2	25.6 a	25.1 a	26.5 a	0.117	1.7	5.9
Wk3	25.0 b	27.0 ab	28.2 a	0.018	2.3	7.6
Wk4	27.2 a	28.1 a	28.3 a	0.643	2.6	8.4
Wk5	28.5 a	28.3 a	30.3 a	0.149	2.6	8.3
Wk6	29.9 a	30.7 a	32.4 a	0.099	2.6	7.5
Wk7	31.4 a	30.7 a	33.0 a	0.073	2.4	7.0
Wk8	33.2 ab	30.9 b	34.2 a	0.042	3.0	8.2
Wk9	33.0 a	32.5 a	34.9 a	0.188	3.3	9.0
Wk10	34.4 a	36.7 a	38.4 a	0.061	3.4	8.4
Wk11	35.1 a	36.1 a	40.0 b	0.196	3.5	8.8
Wk12	38.1b	40.8ab	45.8 b	0.044	4.7	10.5

Means followed by the same letter within a row are not significantly different according to Fisher's protected least significant difference test
L.S.D = Least significant difference; C.V = Coefficient of variation



Significant at p<0.05

Figure 1. Effect of Finishing Ration Formulae on the Live Weight (kg) of Dorper Sheep over a 12-Week Finishing Period

However, livestock production in Kenya has been adversely affected by drought in terms of quality and quantity of feeds. This has led to low levels of productivity, high mortality, reduced market value and community stagnation out of poverty. The developed finisher ration for Dorper sheep is able to reduce the rearing period to attain a market weight of 45-50 kg within 6-7 months instead of 36 36-month (3-year) rearing period. According to (Tegegne, 2016), with intensive sheep fattening on concentrate-based Total mixed rations (TMR), the highest daily gains and optimal feed conversion efficiency were achieved. The purchase of stock and the cost of feeding are the major economic outlays in sheep-fattening agribusiness. Thus, the feeds should be cost-effective(Anja & Hesebo, 2019; Assefa, 2020; Kokeb et al., 2021).In the tropics, dressing percentage with respect to slaughter weight has been reported to range from 45 to 55 per cent(Gelgelo et al., 2017). This is in agreement with findings of current studies whose dressing percent ranged from 45-51 per cent (Table 2).

Organoleptic Evaluation and Meat Quality Assessment of Experimental Sheep as Influenced by Finishing Ration

The lamb on outdoor grazing (control (TR0) reported a heavy worm infestation that is zoonotic in the nature-hydatidcyst (*Taenia hydatigena*. This depicts poor animal health and husbandry practices that can be associated with extensive outdoor grazing, including poor worm control on both livestock and dogs. All outdoor grazed livestock must be dewormed using appropriate dewormers as recommended and advised by the Veterinarian or Para Veterinarian. This is a variable cost that negatively affects the farm's profitability. The lamb under the control treatment had lower live

weight and poor kill-out yield, an implication of inadequate mineral and nutritional balance during the feeding regime to allow for balanced fat and muscle deposits. This is also corroborated by the poor conformation at the loin, which had very poor fatdistribution.

The lamb on TR8 had a kill-out yield of 51 per cent had well-distributed intramuscular and subcutaneousfat cover depicting high feed conversion efficiency and probably a high protein and energy ratio (Table 2). All excess fatty acids from digestion were converted to adipose fat that was well distributed, including the heavy omentum fat layering. The lamb on TR6 had a 50 per cent kill-out yield and had lean meat, good fat distribution, well-marbled, and low subcutaneous fat cover. This could be attributed to a high protein ratio in the diet with a moderate energy level. The animal was also still growing, and this justifies the meat'stenderness and leanness. The higher the kill-out yield, the better the farmer's profits. In terms of overall rating, the carcasses on test feed trials had better meat quality as compared to the control treatment group.

Table 2: Carcass meat grading

Treatment	Body Condition	Live wt (kg)	Dead Wt (kg)	Kill out %	Age (Months)	Marbling & loin thickness	Final Met Grade	Worms	Tenderness & distribution
Control	Fair	40	18	45%	7	Poor	Mutton grade 2	Hydatid cysts and Stilesia hepatica recovered	Tougher meat and Poor fat distribution
Ration 8	Good	43	22	51%	8	Good	Mutton grade 1	Nil	Very Good Fat distribution and tender
Ration 6	Good	44	22	50%	7	Good	Lamb Grade 1	Nil	Good fat cover and very tender

Roasting Assessment

Carcass on Ration 8 was well-marbled, tasty, and juicy on roasting. The ribs were appealing to the taste buds of the roastedmeat eaters. These meat traits are good for barbeque preparation (Atsbha et al., 2021). Carcass on Ration 6 was tasty, soft, and tender with less fat cover on roasting. These characteristics are best for marination and stewpreparation. The control carcass was less fatty, less tender, and tough roasted meat. This is a disadvantage as it tends to burn upon roasting due to low-fat cover. This sampling was based on roasted meat alone. Sampling of fried or boiled meat is recommended for future studies.

Fig.2. Ration 8 carcass

Fig 3. Marbling on the ribcage of Ration 8

Fig.4. Carcass from the control

Fig 5. Carcass of lamb on Ration 6

5.0 CONCLUSION AND RECOMMENDATIONS

Conclusion: Current research findings from this research work conclude that the rearing period from birth to marketing of Dorper sheep can be shortened from 2-3 years old to about 6-7 months only. In turn, the farmer will increase the rate of returns and farm enterprise profitability. Experimental animals on ration TR 8_reached the targeted market/slaughter weight of >50 kg within 6-7 months old. Rations 6 and 8 emerged as most performing in terms of growth performance and orgaleptiptic evaluation/meat quality. However, ration 6 would be more expensive due to high CP levels (16%). Based on ANCOVA results, the

IRR analysis shows Ration 8 appears to be the most financially viable option for agribusiness in Kenya. It offers a strong return on investment and aligns with the average profitability of the sector (FAO, 2023; Khadka & Thapa, 2020). Ration 6 with (18 %) is also profitable but to a lesser extent. The control group (0%), with no profitability, serves as a baseline and highlights the potential benefits of using the tested rations; it also emphasises the importance of using effective rations to maximise returns. Thus, ration 8 (CP 14%; ME (MJ/kg DM) is recommended for dissemination and commercialisation among smallholder pastoral Dorper sheep keepers in the ASALs.

Recommendations: In addition, the study's findings have significant potential for enhancing food security and rural livelihoods in ASALs. Smallholder farmers can increase market turnover and profitability by shortening the Dorper sheep rearing time from 2-3 years to 6-7 months. The application of ration TR8, which combines optimal growth performance and cost efficiency, could result in higher household incomes and more sustainable farming methods. Furthermore, the shorter production cycle provides for greater flexibility in responding to market demands, which may help to stabilise the regional meat supply. This innovation also promotes resilience in ASALs, where environmental constraints frequently limit productivity, by providing a viable and scalable solution for improving livestock-based livelihoods and contributing to regional food security. Lastly, the government should organise pastoralists in groups that are objectively created to adopt the ration 8 within the ASALs areas. The groups can provide a platform for discussing, co-creating solutions and implementing a community-based intensive production system (feedlot). This approach would also encourage the government to give incentives on key feed ingredients used in the formulation of ration 8, promote group marketing of small ruminant products and improve access to credit facilities for pastoralists.

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